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| **Lesson Title: International Space Station and Photography** |
| **Subject area / course / grade level: 5th grade Science and Language** |
| **Introduction:**  Since the early days of human spaceflight, astronauts have gazed down at Earth below and captured photographic images of objects of interest. These targets have included various landforms, bodies of water, population centers, powerful hurricanes, and even atmospheric features such as the aurora. Thousands of such images are now archived and available online to the public through the website - The Gateway to Astronaut Photography of Earth (http://eol.jsc.nasa.gov). Many astronaut Earth images are also combined with those captured by aerial photography and satellite imagery for use in the popular virtual globe program - Google Earth (http://earth.google.com/). By selecting the Astronaut Photography option under the NASA menu in the Gallery Layer of Google Earth, you can view numerous locations across the Earth that have been photographed by astronauts.  Today, most astronaut photography is conducted with a high quality digital camera through a window in the Destiny module of the International Space Station (ISS). Prior to serving as crew members aboard ISS, astronauts are trained by the Crew Earth Observation (CEO) team at the NASA Johnson Space Center in Houston, TX. The CEO team consists of geoscientists, oceanographers, and atmospheric scientists, and their goal is to prepare the astronauts for acquiring images that would be both high quality and scientifically useful. Once aboard ISS, the astronauts are sent a daily “wish list” of image targets over which ISS will pass during its orbits.  ISS orbits Earth from west to east along a straight path that is inclined 51.6 degrees at the equator. This orbital inclination limits the path of ISS to fall between 52 degrees north latitude and 52 degrees south latitude – therefore, it never passes over Earth’s poles. During the spacecraft’s ninety-minute orbit, Earth continues to rotate below from west to east resulting in ISS completing each orbit approximately 22.9 degrees of longitude west from where the orbit started (measured at the equator). When displayed over a flat map of the Earth, the orbit of ISS appears as a repeating wave shifted westward with each orbit (See Fig. 1). This orbital geometry, combined with Earth’s continuous rotation, places ISS passing over the same general area on Earth’s surface once every three days. |
| **Lesson Length: 5 hours** |
| **Materials:**  Computers with Internet access, additional materials on the ISS, large sheets of paper, construction paper, colored markers, pencils, paper, Earth globe, string, tape, protractor, Google Earth, Targets of Opportunity Student Guide.  **Web Resources:**  [**www.spacekids.com**](http://www.spacekids.com)  [**www.pbs.org**](http://www.pbs.org) |
| **Lesson Overview:**  ●The ISS will orbit the Earth, allowing humans to live and work in space for long periods of time.  ●Scientists will be able to study the long-term effects of microgravity (the weightless environment of the ISS) on humans, as well as chemical, physical, and biological processes. These studies should lead to advances in medicine, technology, industrial materials, and in other practical areas.  ●The ISS also serves as a stepping-stone to the solar system because to undertake such missions, we must first understand how humans can survive in space for such long journeys.  ●Sixteen countries are working together to build the ISS: the United States, Russia, Canada, Japan, Brazil, and the nations of the European Space Agency (Belgium, Britain, Denmark, France, Germany, Italy, the Netherlands, Norway, Spain, Sweden, and Switzerland).  ●The ISS is being assembled piece by piece in space. Enormous and heavy, it can only be built in microgravity.  ●The first component of the ISS was Zarya, the control module built by Russia. It was launched into orbit in November 1999 and was followed a few weeks later by the U.S. module Unity. The two modules were connected in space—beginning an assembly that will include over 70 more components and take at least six more years to complete. |
| **Tennessee Standards:**  **Language Arts:**  **●** Demonstrate confidence and poise in various speaking situations  ● Demonstrate critical listening skills essential for comprehension and evaluation  ● Engage in problem solving through group discussions  ● Present and support ideas/opinions in group discussions  ● Demonstrate appropriate language structure, tone and voice control in oral communication  **Science:**  ●Understands the relationships among science, technology, society, and the individual.  ●Understands the nature of technological design.  ●Identify questions that can be answered through scientific investigations.  ●Think critically and logically to make relationships between evidence and explanations.  ●Develop an understanding of the structure of the Earth system.  ●Develop an understanding of Earth’s history.  ●Develop understanding of science as a human endeavor.  ●Develop understanding of the nature of science.  ●Develop understanding of the history of science. |
| **Lesson objective(s):**  **Students will:**  1. Understand that an environment with almost no gravity challenges humans living in space. Humans must  adjust their diets, sanitation, and sleep patterns; wear space suits; and conduct specially designed experiments.  2. ISS inhabitants perform the daily functions of life in space using special products and procedures.  3. Learn how the inclination of orbit of the International Space Station determines its path over Earth.  4. Model an orbital path of the International Space Station using an Earth globe and string.  5. Model an orbital path of the International Space Station using Google Earth.  6. Identify and list geographic and geologic features of the Earth found along the a model orbital path of the  International Space Station using Google Earth.  7. Determine scientifically useful targets for astronaut photography using Google Earth. |
| **ENGAGEMENT:**  **TTW:** Show a short video about the International Space Station. TTW ask, “What do you think astronauts can see on Earth while in outer space?  **TSW:** Locate the 16 nations that are working together to build the ISS on a world map. If the students have otherquestions about the ISS, have them find answers in the following websites:http://www.spacekids.com/spacenews/ and http://www.shuttlepresskit.com/ISS\_OVR/.  Next, ask students what they think it is like to live in space. Begin with a brief discussion of microgravity, the weightless environment of the ISS. Have them consider everyday activities, like eating, taking a shower, and using the bathroom. What might be some challenges of living on the ISS? Tell the class that they will be working in groups and using the Internet or other resource materials to answer questions about living in space.  Divide the class into five groups and give each group a set of questions outlined below. Each group will use the Web resources provided to answer questions. All the questions relate to the daily life of astronauts and cosmonauts in space. Students should record their findings on the Classroom Activity Sheet: How Do Astronauts Live in Space?  Group 1: Food  How has the food that astronauts eat changed over the last 50 years?  What kinds of foods do astronauts eat in space today?  What methods are used to prevent food from spoiling?  If you lived in space for a month, what foods do you think you would miss the most? Why?  Web Resources [Frankfurters in Orbit](http://www.spacekids.com/missions/food_sts106_000828.html)  Top 5 Foods Astronauts Request  [Eating in Space](http://www.pbs.org/spacestation/station/living_eating.htm)  Group 2: Space Suits  What are the main parts of a space suit? How do they work?  Do astronauts have to wear the space suits all the time? Why or why not?  What are some safety measures that are built into space suits?  Do you think space suits are comfortable? Why or why not?  Web Resources  [Space Suit: How it Works](http://www.utc.com/discover/hiw-emu.htm)  [Space Suits](http://www.pbs.org/spacestation/station/living_spacesuit.htm)  [The Space Suit (history)](http://www.hq.nasa.gov/office/pao/History/SP-4026/noord47.html)  [What is It Like to Wear a Space Suit?](http://www.itss.raytheon.com/cafe/qadir/q2470.html)  Group 3: Extraterrestrial Experiments  What are some examples of experiments that are conducted on the ISS?  What do scientists hope to learn about life in space?  How do scientists conduct controlled experiments in space?  Name two findings that have emerged from experiments done in space.  Web Resources [Home in the Sky: International Space Station](http://www.discovery.com/stories/science/spacestation/spacestation.html)  [NASA Watch](http://www.nasawatch.com/station.news.html)  Group 4: Sanitation in Space  How do astronauts shower and use the bathroom in space?  Do they have to wash dishes or laundry?  How do they keep their living quarters clean?  What special sanitation issues do astronauts face that those of us on Earth don’t worry about?  Web Resources [Three Bedrooms, One Bath, Great Neighborhood (article)](http://www.spacekids.com/missions/ISS_next_000828.html)  [Sanitation](http://www.pbs.org/spacestation/station/living_sanitation.htm)  Group 5: Sleep and Relaxation  Do astronauts require more or less sleep than normal when they are in space?  How many hours of sleep do astronauts usually get each night?  How do astronauts relax in space?  Do astronauts sleep in a bed? If they do not, how do they sleep?  Web Resources [Recreation and Sleeping](http://www.pbs.org/spacestation/station/living_sleeping.htm)  After completing the research and filling out the classroom sheet, have each group present its findings to the class. Students should use their Classroom Activity Sheet to take notes. As a follow-up homework assignment, assign the Take-Home Activity Sheet: A Week in Space. Students should use what they learned from the presentations to complete their essays.  The students will research and read background information about the history of astronaut photography and use Google Earth to create a model orbital path of the International Space Station.  The teacher will model the orbital path of the International Space Station. Afterwards TTW call on students to model. |
| **EXPLORATION:**  TSW use Google Earth to create a model orbital path of the International Space Station. |
| **EXPLANATION**  Think-Pair Share, Text Connections  TSW sketch and create a list of surface features of Earth found along a model orbital path of the International Space Station. |
| **ELABORATION: Discussion questions**  1. What are some of the challenges astronauts face living in a microgravity environment?  2. Why must the ISS be constructed in space rather than on the surface of a planet?  3. What was the space race? What factors led to the United States and Russia collaborating on the ISS?  4. Who first suggested the idea of creating the ISS? Has it always been called the “International Space Station?” If not, what was its former name?  5. If astronauts traveled to Mars, they would be away from Earth for more than a year. What problems do you think being in space for a year would cause? For example, would the astronauts face health problems, and would the equipment be able to remain in space for so long without maintenance? What could be done to address these and other problems?  6. The cost of completing the ISS will exceed $60 billion. Do you think that the benefits of this project justify this astronomical cost? If not, how would you recommend this money be spent?  TSW examine different locations on Earth obtained by astronaut photography and describe the surface features that appear in the pictures. |
| **EVALUATION:**  After completing the research and filling out the classroom sheet, each group should present its findings to the class. Students should use their Classroom Activity Sheet to take notes. As a follow-up homework assignment, assign the Take-Home Activity Sheet: A Week in Space. Students should use what they learned from the presentations to complete their essays.  Students should be able to work cooperatively in groups; research their questions thoroughly and accurately; make an interesting presentation to the class; and write accurate, lively essays about a week in space. Use the following three-point rubric to evaluate students’ work during this lesson:  **●Three points:** Students worked effectively in their groups, researched all their questions thoroughly and accurately; presented their findings to the class in an interesting and creative way; and wrote convincing, accurate essays about a week in space.  **●Two points:** Students worked somewhat effectively in their groups; researched most of their questions thoroughly and accurately, presented their findings to the class in a satisfactory way, and wrote a satisfactory essay about a week in space.  **●One point:** Students did not work very effectively in their groups; researched one question thoroughly and accurately, presented some information to the class, and wrote a few sentences about a week in space.  **●** The students will choose potential targets for astronaut photography and suggest scientific questions that the images might help answer. |